MANUEL GAMIO

THE MINIMA AND THE ELECTRON

(CONJECTURES OF AN AMATEUR)

MEXICO
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THE MINIMA AND THE ELECTRON

It cannot be logically accepted that the electron represents the ultimate division of matter, as theoretical and experimental arguments show.

1.—In accordance with the equation for matter and energy established by Einstein (1 gr. = 9 x 10 ^{20} ergs) a definite magnitude of energy comes from a difinite mass of matter. What mass then must the material particles have whose transformation yields the quanta, or smallest emissions of energy? Such material particles cannot be the electrons because the mass of these which is $9x10^{-28}$gr. is equivalent to a quantity of energy equal to $9^{2}x10^{-8}$ erg. (1), which is incomparably greater than the energy of any quanta. Material particles must therefore exist whose mass is much smaller than that of the electron.

2.—In the Compton effect, in cosmic rays, inphoto- electric emission, and in other phenomena the existance of corpuscles or material particles is revealed whose mass must be incomparably smaller than that of the electron.

The conclusion apparently the most logical suggests that the smallest existing particles, which will hereafter be called *minima*, are those whose masses are equivalent to the magnitudes of the quanta, or smallest emissions of energy, according

(1) $9 \times 10^{20} \times 9 \times 10^{-28} = 9^{2} \times 10^{-8}$

to the formula of Einstein given above. The smallest particle of sodium, for example, (when this element is emitting yellow light) is not the electron, as has already been said, but a particle whose mass is 0.377×10^{-32} gr., because on its transformation it produces the quanta 3.4×10^{-12} ergs which the atom of sodium emits (1). Likewise the mass of the smallest particle of the atom which emits red light is of 0.333×10^{-32} gr. because it is equivalent to 3×10^{-12} erg, which is the magnitude of the quanta of red light.

Now then if we divide the mass of the electron 9×10^{-28} by the mass of the minimum of sodium 0.377×10^{-32}, the number 2 3 8 000 is obtained, which is the number of minima which make up an electron of sodium when that element is emitting yellow light.

The number and the mass of the minima which make up the electron are not constant, but vary indefinitely, since the electron of one element can emit quanta of different magnitudes under certain conditions or special circumstances as happens with metals which when they are hoy emit light of different frequencies and wavelengths, beginning with red light. (2)

All the electrons are made up of minima, but from the point of view of their functions and place in the atom they may be classified as *interior* and *exterior*.

INTERIOR ELECTRONS.—These when united with the protons form the neutrons of the nucleus and constitute the principal source of radiation of the atom.

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(1) $\frac{3.4 \times 10^{-12} \text{ erg}}{9 \times 10^{20} \text{ gr.}} = 0.377 \times 10^{-32}$ gr.

(2) The minima which compose the electrons of an element differ in number and mass form the minima which form the electrons of other elements, in spite of which, the electrons of all elements, have the same mass, which is the constant, 9×10^{-28}. The constant of Plank establishes that although the quanta of energy differ in their magnitude as well as their periodicity, nevertheless the products obtained by multiplyin en quanta by its periodicity are always 6.55×10^{-27}.

The minima cannot conserve their corpuscular character, nor can they exist isolated outside of the field of gravitation of the interior electron. The frequency of transformation of the minima varies with the degree of subdivision of the electron to which we now refer. For example, in the atom of sodium which is emitting yellow light, 1.9×10^{15} minima are transformed into energy in a second, and as the electron of sodium is made up of 238,000 minima, the deduction is that the number of electrons of sodium transformed into luminous energy in a second is 5×10^{9}.

EXTERIOR ELECTRONS are those wich are placed around the nucleus and at a certain distance from it as groups of minima. These electrons may be considered as instruments of the atom in the chemical reactions and other phenomena, and they have the power to emit energy by the same process by which the interior ones do, that is, by means of the periodic transformation of their minima. Under certain conditions this transformation can take place even when the electron has been displaced outside of the field of gravitation of the atom. The minima may exist with their corpuscular character outside of the field of gravitation of the exterior electron and of the atom, that is to say, they exist isolated in space, without forming groups or electrons, and under these conditions they may still transform themselves into energy. For example cathode rays are exterior electrons displaced from the fields of gravitation of their respective atoms. The impact of these electrons in the vacuum tube gives rise to X–rays, or a certain state of subdivision of the electron into minima or of subsequent transformation of these into energy. Nevertheless not all minima become transformed into X–rays, for after the impact a certain proportion of them conserves its corpuscular character, but singly, without forming electrons. Later these minima may transform themselves into new emissions or quanta of energy, either as the result of a new impact, or through other causes.

For example, in the Compton effect, when the cathode electrons strike the molibdenum target (Fig. 1) their minima are partly transformed into new luminous quanta, while a certain number of them conserve their corpuscular nature. This mixed

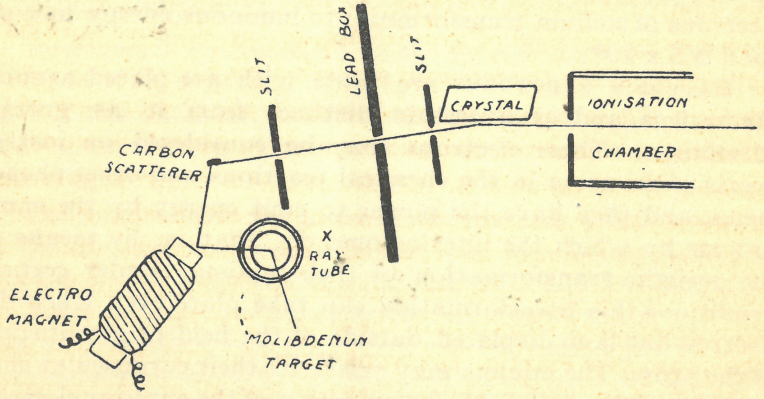

Fig. 1.

train of waves and minima latter impinges on the carbons catterer and by this impact the minima are transformed into new luminous waves. Lastly, the double train of original waves and of new waves pass through the slits and reach the Bragg crystal of the spectroscope where the length of the two is measured. The Stokes and anti–Stokes lines of the Raman effect can be interpreted as produced by isolated minima which arrive with the waves of monochromatic light and wich on passing through organic liquids and other substances are transformed into new quanta of luminous energy.

Let us visualize how the interior electrons function in an atom with respect to the exterior ones, and vice versa. In the interior electron the transformation of a minimun into a quantum of energy is equivalent to the production of a wave, and as these transformations are very frequent, the electron is concluded to possess permanently an undulatory character. On the disappearance of the mass of each minimum transformed into energy, the field of gravitation of the electron automatically changes for the remaining minima tend to seek a new equilibrium. These variations produce one mode of vibration of the electron, the neutron, the nucleus and the atom. When all the masses of the minima in the electron of a neutron have been transformed into energy, the remaining proton is expelled from the atom by the protons isolated from the nucleus, and it can carry with it one or more exterior electrons, producing thus another mode of vibration of the atom. The remaining protons, neutrons, and exterior electrons move to find another state of equilibrium. When the nuclues has lost all or a large part of its neutrons and exterior electrons, the atom becomes desintegrated since its isolated protons repel each other and disperse to find other protons or electrons with which to combine. The disappearance of an atom produces a disequilibrium among the remaining atoms which constitute the molecule, and this changes the field of gravitation and sets up a mode of vibration of the molecule. Lastly, the molecular movement is the result of the periodic disappearance of moleculas and of the movement of others which seek new and successive states of equilibrium.

In certain states of subdivision and emission of energy of the electron, such as those of the octave of light and of the X-rays, the luminous energy of each minimun of the interior electron

carries with it beyond the atom the isolated minima of the exterior electron which conserve their corpuscular character. This explaineds the fact that light is of an undulatory nature as the phenomenon of interference proves, and at the same time of a corpuscular character, as is shown by the photo-electric effect, produced by the corpuscles, which, incorporated whit the light waves, are transformed into energy on reaching the metallic surface. This energy in its turn dislodges exterior electrons of the atoms of the metal. These, lastly, produce the electric current of the photo-electric cells.

How is Matter and Energy Generated?

We do not know the reason for the transformation of matter into energy, but we suppose that conditions in space, analogous to those which determine gravity, fix the different states of degrees of subdivision into minima which characterize, the electron. Perhaps the different phases of energy also represent states of the subdivision of the minimun. If this is so, the electron would be the limit of subdivision in which the phisical and chemical characteristics of matter are conserved. In the minimum these characteristics begin to disappear, and when the minimum is in its turn subdivided, to the resulting states of its subdivision correspond the physical and chemical characteristics of energy.

We have stated that the electrons are periodically and continually transformed into energy, but we did not add that this transformation is continuous to a certain limit but that out side of this limit it no longer takes place. As a result of experimental conclusions which Onnes Holst, Brillouin, Ernst, and others obtained at very low temperatures on specific heat, thermo-electric potential of metalic couples, resistance of metals, degeneration of the atom, etc., it may legitimately be deduced that

matter radiates energy, that is to say, that the minima begin to be transformed into energy above the absolute temperature of 0. (-273° C). At absolute zero, not only the heat radiations but probably too all emissions of energy and electromagnetic waves stop, and the electrons, protons, neutrons, atoms, and molecules stop vibrating and moving.

The electron therefore has two fundamental states, in addition to those having to do with the subdivisions of its minima. In the first state, namely that above absolute zero, its character is corpuscular and undulatory, and in the second state, or at the temperature of absolute zero, its character is exclusively corpuscular, for the minima are not transformed into energy, nor are waves emitted, the same being true of the atom in general.

Theortetically, that is from the point of view of physics and mathematics, matter is transformed into energy, and vice versa, according to the equation of Einstein, but from the experimental point of view matter is not transformed into energy at absolute zero. What then happens with the energy at this temperature? Perhaps certain conditions of space cause energy to be transformed into matter at absolute zero, it being logical that the first part of this process consist in the periodic transformation of quantas of energy into minima of matter.

The transformation of quantas into minima cannot take place in the heavenly bodies, but outside of them, for their temperature is above –273° degrees.

These proposition invites speculation as to the genesis of the nebulae.

Let us suppose that in a certain zone of space conditions begin which result in a temperature of absolute zero. The energy of the emissions, or luminous waves, heat waves, or electromagnetic waves, which are crossing that zone immediately begin to be transformed into minima according to their respective periodicity. If a strong field of gravitation such as that produced by a heavenly body does not already exist in the zone the first minima group themselves so as to forma a center

of gravitation toward which the others converge which are progressively being formed. The successive concentrations and condensations of the waves impose a slow movement of rotation upon this agrupation of minima, which in its turn begins to gravitate toward celestial bodies outside of the zone considered. This is the initial state of the evolution of a nebular body, which is very thin in structure, for although the minima which compose it are grouped together, the distances which separate one from the other are very large, Moreover, the mass of each one is more or less 3×10^{-32} gr., according to the magnitude of the quanta of energy which originated it. As long as conditions of absolute zero prevail the minima remain apart and canot emit luminous or other radiations, for which reason they are invisible, the nebula being a dark or opaque one. Such conditions may be the cause of dark regions in space such as the dark lanes and dark markings, which may be seen in the milky way of our galaxy.

When celestial bodies with strong fields of gravitation exist in a zone of absolute zero, the minima are hurled toward them, but as they are invisible, it is impossible to observe under what conditions the phenomenon takes place. If such is the case of the Earth, it could be supposed that the cosmic rays are minima of an opaque nebular body just beginning about the planet. The great penetration an the high frequency of the cosmic rays could be explained if the penetration were due to the velocity given to the minima by the concentration and condensation of the waves themselves, and to the effect of gravitation, whereas the frequency is due to the fact that waves of different frequencies, heat waves, light waves, etc., are being transformed into minima at the same time, so that the frequency with which these are generated and projected against the Eart his equivalent to the sum of the frequencies, of the various electromagnetic waves which give them origin.

When the conditions which give rise to the formation of the opaque nebula change, as for instance when the temperature

rises above absolute zero, the minima group themselves more closely together and begin to be transformed into heat, light or other forms of energy. In this stage of evolution the nebula is *diffuse and luminous*, and its rotatory movement as well as its gravitation toward celestial bodies outside of the zone in which the nebula is formed are accelerated. To this type the nebula of Orion probably belongs. When there are celestial bodies within that zone, the nebulous body can completely envelop them as in the case of the Pleyades, unless it becomes anular as in the nebula of Lyra, or in the rings of Saturn.

In later stages the minima group themselves closely together, forming electrons, protons, neutrons, atoms, elements, and combinations of elements. In the evolution of its shape the nebula may be spherical, spherical with flattened poles, lens-shaped, disk-shaped, or in the form of whirlpools, such as the spiral nebulae. In the last two stages the atoms, elements, and combinations of elements which exist in the periphery accumulate in great masses of matter and these in their turn form stars, planets, satellites, etc.

Suggestions in the Experimental Field

Because of having no laboratory or technical preparation for experimentation, the author has not made certain experiments which have occurred to him, for which reason he suggests that others with the proper training and facilities make them, if they seem logical and practical.

The Equivalence of Matter and Energy

Einstein has theoretically established the equivalence of matter and energy by the equation 1 gr. $= 9 \times 10^{-20}$ ergs, but experimentally it is impossible to measure not only a mass of a trillionth of a gram, as in the case of this formula, but not

even a ten millionth. Even in radioactive bodies it is impossible to prove that equivalence, although a mass of a ten thousandth of a gram is involved, for the experimental obstacles are insuperable.

Combustion is one of the phenomena in which the transformation of matter into energy can perhaps be investigated with some degree of sucess. Unfortunately the combustion of a body or element is not absolute, for various phenomena, such as the chemical combination of the body or the element in question

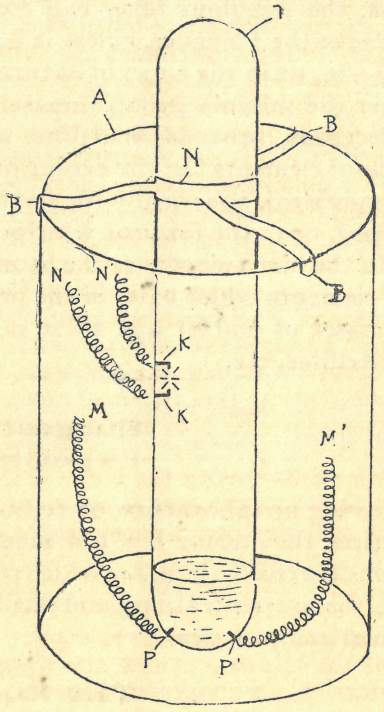

Fig. 2.

with another or others, always interrup it. If the combustion of an element could be indefinitely prolonged or repeated, it wold disapear, transformed into light and heat energy. We suggest an experiment by which the decrease of the mass of an element

in continual combustion might perhaps be measured, as well as the magnitude of the energy set free.

The recipient A (Fig. 2) contains water at a low temperature (let us suppose at 0° Centigrade). Within is placed the tube T by means of the ring N and the two arms B. This tube contains a certain amount of acidulated water. In the walls of the tube there are two platinum electrodes K K', between whose free terminals the electric spark leaps. Two other platinum electrodes, P P', are placed in the bottom of the tube and have for their purpose the electrolysis of the water.

At the beginning of the experiment the tube is not yet placed in the container nor are the four electrodes connected with the conducting wires, MM'. and NN'. Throuhg the upper part of the tube which is still open a little water is poured and it is heated so that part of it evaporates and expels the air. Then the tube is closed by means of a blowpipe. Then its surface is carefully cleaned and dried and it is weighed in a highly sensitive balance before placing it in the recipient A.

The passage of the current through the conductors MM' and the electrodes PP' is constant so that the production of electrolytic Oxygen and Hydrogen is also continuous. The passage of the current though the conductors NN' and the electrodes KK' is interrupted at regular intervals, for instance every minute, so thath during this interval the water may have been able to be transformed into Hydrogen and Oxygen. As the spark leaps between KK' the two gases combine to form water vapor which condenses on the walls of the cold tube, collecting at the bottom. The process is repeated at each minute. Each time Oxygen and Hydrogen combine the amount of energy given off must be measured by photometric and calorimetric methods. Likewise the heat and light energy given of each time by the electric spark is calculated in order to subtract it from that produced by the chemical reaction.

After a certain time during which the apparatus has been functioning continually, for example 24 hours, or 1440 combinations of Hydrogen and Oxygen , the tube is taken from the container, and after cleaning and drying it so that it might be the same on the outside as at the beginning of the experiment, it is weighed in the sensitive balance to determine the difference in weight since the beginning. This difference expresses the mass of Hydrogen (or of both gases) which have been transformed into energy. The calorimetric and photometric measurements

will indicate the amount of energy produced. The proportion between the mass of the former and the energy of the latter are compared with the theoretical proportion given in the formula of Einstein. If in the 1440 combinations no decrease in wieght is noted the experiment must be continued for as long a period of time, as may be necessary.

The Existance of the Minima

The existance of minima could be proved or disproved experimentally by various means, for example in the Compton and Raman effects.

In the case of the Compton effect, (Fig. 1) the positive pole of a powerful electromagnet must be placed betwen the molydenum target and the carbon scatterer in order to deflet the train of waves and minima from the target to the acatterer, for which purpose the said pole is carefully polished. If the minima exist and are particles of negative electricity, they will be attracted by the positive pole, and only the original train of waves will reach the scatterer, and the espectroscope will not find lines corresponding to new waves.

In The case of the Raman effect the beam of monochromatic light can also be deflected by the pole of the electromagnet before it reaches the liquid, the gas, or the solid, which make the Stokes and anti-Stokes lines appear under normal conditions. If the minima exist they will be attracted by the pole and the Raman effect will not be produced because there will be no new secondary waves, nor Stokes or anti-Stokes lines.

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